A Review of the Potential for Development of Cashew Production in the Zona Paz Region

Guatemala-CAP Income Generation Activities Project (AGIL)

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Contract #
520-C-00-00-00035-00

June 2001

Prepared for
United States Agency for International Development/
Guatemala
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A REVIEW OF THE POTENTIAL FOR DEVELOPMENT OF CASHEW PRODUCTION IN ZONA PAZ REGION, GUATEMALA, CENTRAL AMERICA

In addition this report recommends a plan for the implementation of the recommended strategy.

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AGIL PROGRAM
(Apoyo a la Generacion de Ingresos Locales)
US Aid/Guatemala CAP income Generation Activities in Rural Areas
Guatemala City, Guatemala.

June 2001

1.0 INTRODUCTION

1.1 AGIL Program

Conditions in rural areas of Guatemala are poor due to the impact of previous chronic under-investment in social infrastructure, linguistic and cultural fragmentation and one of Central Americas most violent social conflicts. As a consequence rural incomes and social indicators in Guatemala are very low in comparison with many other countries at a similar stage of economic development.

US Aid/Guatemala's income generation objective in to pursue sustainable increases in household income and food security for the rural poor in selected geographic areas of the country. These efforts are being focused on six rural departments in the indigenous western-highland, north-lowland regions and also in the Zonapaz

AGIL (Apoyo a la Generacion de Ingresos Locales) is a program designed (1) to assist small farmers in higher value production and marketing, and (2) micro-entrepreneurs expanding their business. A principal component is to establish accredited technical services to assist producer groups in all aspects of their business, and includes assistance to look for new crops to diversify into new areas. As AGIL is a short term project most diversification has been on similar crops currently produced. However new ventures on long range crops with potential also new need to be made. One of these crops is cashew for both the nut and the fruit.

Abt Associates Inc are managing the AGIL program in Guatemala, and they retained the consultant for project AGIL/2000/HCN-24 to investigate the potential for cashew production in the defined project area.

1.2 This Study

The consultant visited Guatemala for two weeks in May/June 2001 to undertake the following TOR,

- carryout site evaluations in selected municipalities
- provide training to potential producers
- supervise planting of nursery and provide instruction of stock
- participate in one day seminar for interested producers
- provide other recommendations for cashew plantings in Guatemala as requested.

As part of this assignment 25 kg of selected cashew seed was imported from Australia and these were propagated in a nursery at Agropecuria Popoya. These cashew trees are to form the basis of a new cashew gene pool for planting in suitable areas identified in the project areas.

AGIL has a mandate to work in eleven municipalities however the seven municipalities of Caracha, San Juan Cotzal, Chajul, Nebaj, Barillas and Estancia de Virgin were initially eliminated as being clearly environmentally unsuitable for cashew. The assignment was adjusted to concentrate on the four municipalities of Rabinal, Chisec, La Liberdad, and Chajul as having potential for this study.

REVIEW SECTION

1.0 REVIEW OF CASHEW HORTICULTURE

1.1 General Characteristics of Cashew

Cashew (anacardium occidentale) is a tree native to north east Brazil that was transplanted by the Portuguese in their other colonies (mainly Goa and Mozambique) during the 16th century. The tree was later widely distributed to many tropical countries although to day there are only a few major producers.

The cashew is an evergreen perennial tree that may grow as high as 15 metres in favourable conditions. There is also a sub species found in Brazil - the 'dwarf cashew' that grows only to three metres.

The cashew tree produces a nut (raw nut) with the kernel found inside the hard shell. Attached to the raw nut is a false fruit or cashew apple. The main product is the kernel which is obtained by removing the shell (processing) of the raw nut. The normal yield of the kernel may vary from 20 % to nearly 40 % of the raw nut.

The cashew apple which weights some five to ten times the weight of the raw nut contains a high level of Vitamin C and is utilised as juice and other products mainly in India and Brazil. Cashew nut shell liquid (CNSL) is contained within the shell of the raw nut and this product can be harvested by certain processing methods. CNSL is a natural phenol with heat resistant properties and has a market mainly in the motor industry in the manufacture of brakes and clutch linings. The normal level of CNSL recoverable is 8% to 10 % of the weight of the raw nut.

The cashew is a deep rooting tree that has developed a reputation for being both hardy and drought resistant and the ability to survive in poor conditions. It is a heterogeneous open pollinated tree whose seed normally has a wide genetic variation - genetic integrity can be maintained only by vegetative propagation.

Cashew is overwhelmingly cultivated as seedling trees by small farmers in developing countries and they frequently give it a low priority in terms of genetic improvement, site selection and management. As a consequence the yield and nut quality obtained are low. However research in Australia and elsewhere has demonstrated that returns (yield + nut quality) more than ten times the current average can be achieved if sufficient consideration is given to genetic improvement, appropriate site and climatic factors as well as correct management.

In recent years in Australia and elsewhere there has been a movement to introduce improved technology in the production of cashew, however the impact of this change would still be very small in terms of the whole industry. However rising labour and other costs may make this change important for the industry to maintain returns.

1.2 Cashew Morphology

The following are the major points.

Tree Life-Span There is little reliable data on the productive life of cashew. Some authorities show evidence where the tree is still producing well after 50 years. It is also maintained by others that the best productive life may be shorter- perhaps 25 to 30 years. After this time the tree may go into a slow declining phase. It is clear however that the growing conditions will have an important bearing on life span and development of the tree.

Tree Canopy A healthy tree not suffering severe disease or pest attack should demonstrate a thick canopy even at the end of the dry season. A tree with a sparse canopy usually indicates some unfavourable condition.

Root System In favourable conditions (deep, well drained sandy soils) the tree can develop extensive lateral root system and a deep tap root - . (in Tanzania it was found that lateral roots in six year old trees could spread 7.3 metres, and in Madagascar it was found that five year old trees could have a tap root descending to below five metres). This allows the trees to capture moisture and nutrients from a large area of soil.

Phenology. The cycle of vegetative and reproductive growth follows a definite pattern where the timing of each phase depends on local climatic conditions. Shoot growth is in distinct flushes, and in hot tropical conditions there are generally three flushes per year. – a monsoon vegetative flush, a floral flush, and a post harvest vegetative flush.

Floral Biology The age the flowering and fruiting commences depends on genetic factors and growing conditions, normally this occurs in 2 - 3 years but in exceptional conditions this could be within the first year of growth. Usually flowering occurs after the growth flush at the end of the rainy season and may extend over four months - however the peak flowering is usually about four weeks after commencement of flowering. Cashew produces both male and hermaphrodite flowers on the same panicle, the ratio is usually about 10 male to 1 hermaphrodite. between the two has been found to vary from 1:28 to 1 : 3.7 (research papers various countries)

Pollination and Fruiting. Insects are the main pollination agent – (native bees, honey bees, flies and wasps). Although a large number of flowers are produced the nut set ratio is low, often due to low sex ratio, poor pollination, and perhaps water availability, nutrition and pest factors. The inclusion of bee hives can sometimes assist pollination. Growth regulators have been used in some countries to attempt an improved ratio of fruit maturity.

Nut and Fruit Development The nut usually becomes visible about one week after pollination and reaches it's maximum size 5 - 7 weeks after pollination. Thereafter the nut shrinks, the shell hardens and the green colour turns to grey. The mature nut is 75 % of it's maximum size (when green) and this loss in size is mainly moisture - the kernel does not change size. The apple makes little development but grows rapidly 20 days after fruit set. In general fruit maturity is considered to occur 60 to 70 days after fruit set

Nut Characteristics Nut size can vary between about 1.5 gm to 30 gm. The ration of shell kernel and testa can vary significantly. Research data shows that the kernel size is usually - but not always not necessarily negatively correlated with nut size. The recovery rate - the most important ratio of kernel (minus testa) to shell can vary from about 18 % to near 40 %. The proportion of testa to whole nut has been found to vary between 1.3 % to 3.6 %. Cashew nut shell liquid (CNSL) is contained in the mesocarp of the shell and it's proportion by weight of the whole nut can vary from virtually nil to about 22 %, however about 8 % to 10 % is normally recovered by processing.

Apple Characteristics The apple can vary significantly in size and shape. It can vary in ratio from 1 : 1 to as large as 1 : 15 to the nut. It contains 85 % juice of which 10 % is invert sugars. Apples are either red or yellow in colour - research has found little difference in colour as a significant characteristic.

1.3 Climatic and Soil Requirements

The cashew as a tropical plant thrives at higher temperatures, and it requires a well defined wet and dry season. Cashew grows well when **temperatures** range from minimum of 15 degrees C to maximum of 38 C. The ideal overall average temperature is considered to be 27 degrees C, and vegetative growth may be restricted if temperature range from 9 to 24 degrees C over an extended period. Mature trees can tolerate low temperatures but young trees will be killed by frost. Rain fed cashew can grow in wide rainfall regime but does best with 1,000 to 2,000 mm **rainfall** with a 5 to 7 month dry season. There is limited information on the ideal water requirement of cashew but it responds well to supplementary irrigation during the dry season and in Australian conditions maximum rates of up to 300 litres/tree/week are considered to provide maximum yields.

Cashew can withstand long periods of low **relative humidity** (ie 25 %) provided the tree has access to sufficient water (irrigation). However high humidity (ie over 80 %) is conducive to the growth of fungus especially anthracnose and to the excessive presence of insect pests.

The best **soils** for cashew are deep well drained sandy or sandy loam soils. Ideally soil depth should be three metres. Cashew cannot withstand badly drained soils either, with a high clay content or compacted soils with a hardpan. The correct soil structure is most important - soil fertility is less important as cashew will thrive in these conditions provided nutrients are applied. Cashew also prefers acid to neutral soils - a pH of around 5.5 to 7.0

1.4 Importance of Genetic Selection

The vast majority of the cashew trees planted in the world are by seed. As the cashew is an open pollinated tree the planting by seed leads to a wide variation in performance. To maintain complete genetic integrity other forms of multiplication are required. In - vitro propagation has not yet proved successful and propagation by cuttings is notoriously difficult. The current effective method for vegetative propagation is by grafting (or budding). Grafting maintains the major benefits of vegetative propagation but the rootstock interaction factor must still be encountered.

The genetic variation in characteristics in the cashew tree can be demonstrated in the following table below

	Characteristic		variation	genetic influence
1.	Tree growth/shape		compact/upright wide spreading	high
2.	nut quality	nut size	2 gm to 30 gm	high
		recovery %	20 % to 40 %	high
		kernel size	0.5 gm to 6 gm	high
3.	time of fruiting		early to late in season	high.
4.	total yield (nuts)		very low to 50 kg	medium, management, inputs have major impact.

Considering the above characteristics (1), **compact and upright tree growth** allows for higher density plantings (and higher yields) as the cashew can only bear fruit on the canopy surface and growth will be depressed if shading occurs. While tree shape can be changed by pruning, this also can have significant detrimental effects in terms of loss of bearing vegetation if pruning is carried out on mature trees. The selection of compact and upright stock largely eliminates the need for subsequent pruning, although minor pruning of young trees is recommended to reinforce the tree shape characteristics carried by the genetic selection process.

(2) **Nut quality** is extremely important – a higher recovery is a defacto yield increase, as crop with 40 % recovery after processing would give double the volume of final product (kernel) as crop with 20 % recovery. In addition kernel size is important as larger kernels fetch higher prices. While nut quality can be influenced to some degree by inputs (nutrition, irrigation), it is mainly determined by genetics.

(3) **Time of harvest** is largely determined by genetics, although this can be influenced at the margin by manipulation of inputs. Selection of varieties for **early fruiting** can be an advantage as this (1) can target the collection of harvest prior to wet season, and (2) this can reduce the period the trees require more intensive management during the year and it reduces the time when the crop is at risk from pest attack.

(4) **Total yield,** (the total number of mature nuts produced by the tree) is determined by a complex range of factors including flower sex ratios, efficiency of pollination, nutritional and moisture status, influence is partly genetic but is significantly influenced by management conditions and inputs (fertilizer). There is also an inverse correlation relationship between nut size and number of nuts produced on the tree.

(5) **Disease and Pest resistance.** There is no scientific evidence but some varieties appear to have greater resistance to diseases like *anthracnose,* and possibly to certain insect pests. This fact can only be determined by observation, however any beneficial characteristics should be noted and allowed for in a selection program.

The value of good genetic selection, especially when in conjunction with good management and inputs is very significant in the plantation. This can range from yields of 500 kg/hectare of poor quality crop to the highest levels of achievement where results may be 5,000 kg/hectare of excellent quality crop – a difference where the **value after processing of the better crop is 18 times greater than for the poor crop.**

There would be also be a very significant improvement in value in the processing factory. During processing, the functions of (1) shelling the raw nuts and (2) peeling testa from the kernel are the major cost items (mainly labour), however there are also additional efficiencies in question. The cost of shelling a given quantity of crop is relatively fixed, but crop with a higher recovery % will result in lower unit costs of shelling, in addition larger nuts and kernels are easier to shell and this results in a lower % of broken grades which gives higher overall prices fro final product. Similarly larger kernels are easier to peel without breakage also resulting in higher value. It is estimated that factory unit processing costs can be reduced by 30 % or more solely depending on the genetic nut quality of the crop.

In addition good quality crop also gives benefits to workers who are usually paid on piece work rates, it allows them to earn higher wages without determent to the factory.

1.5 Management and Inputs

Cashew trees should be planted in the correct **spacing** relative to their tree growth habit and canopy shape to avoid shading. While some light pruning is acceptable the spacing must never be so dense that requires heavy pruning to keep tree canopies apart. Cashew responds well to **added nutrients** as it is usually grown in nutrient deficient soils. Applied nutrients are essential if higher production levels are to be achieved. The major requirement by cashew is for N and K, but a number of micro-nutrients, especially zinc are important.

Nutritional standards for cashew have been developed and a nutritional program can be developed by the taking of leaf analysis to determine the nutritional status of the tree and then nutrients can be added to bring the tree up the nutritional standards. If supplementary **irrigation** is used the soluble nutrients can be applied through the irrigation system.

Cashew is subject to attack by a number of **pests**, the most important world wide is helopeltis – *Helopeltis sp,* or mired bug which cashews damage (necrosis) to vegetative, floral flush or fruit by its' feeding action. Other pests may include thrips including *Selenothrips rubrocinctus*, aphids, moth caterpillars, monoleptra (leaf beetles) and sometimes borer insects. All important pests can be controlled by spray programs, there is also biological control systems developed in areas where the weaver ant *Oecophylla sp* are prevalent. In Central America the pest regime for cashew is markedly different to other cashew growing countries. Here helopeltis is apparently either absent or a minor pest, and the major pest are various species of Leptoglossus – especially *Leptoglossus zonatus.* This pest can cause significant levels of damage to the nut during its' growth in the plantation, and this may only be apparent during processing and in severe cases it can lead to a significant losses of product in the factory. The beneficial insects for cashew are some species of ants, spiders, lacewings, heteropteran bugs and wasps.

Cashew usually has few **disease** problems. The most important disease world wide is antracnose, a fungus disease that can spread easily in conditions of high humidity, temperatures below 30 degrees C, and where there is significant shading of canopy. Damage can be caused to leaves, shoots, flowers and nuts.

3.0 REVIEW OF WORLD CASHEW MARKET

3.1 Introduction to Cashew

Cashew (Anacardium ocidentale L), is a tree of the dry tropics which originated in north east Brazil. It was spread by the Portuguese in the 16th and 17th century to East Africa, and India (Goa) and later mover to many tropical countries.

The cashew is unique in that the tree produces a nut that is external and is attached to the fruit. The nut is processed to release the kernel which is the main product that is utilized as an edible nut. The shell of the nut also contains cashew nut shell liquid (CNSL) - a natural phenol that can be collected during processing as a by-product and has a number of industrial uses as a heat resistant material. The fruit, also known as the cashew apple has a number of uses including eating as fresh fruit by the growers to a number of industrial uses where conditions allow (fruit juice etc).

Cashew is grown in a large number of countries, production is largely by small holder farmers. Only in Brazil are there some large scale plantations, but even there small holders are important. Generally world cashew production has been with low technology using seedling trees and few inputs. Results are also low however because of low labour costs in growing countries the returns have been adequate.

In some countries in response to rising costs efforts are now starting to be made to increase returns. This involves an improvement in the technology of growing cashew using selected grafted trees and more inputs.

3.2 World Cashew Production

The major expansion of the industry occurred after World War Two, by 1949 world production was about 100,000 MT of raw nuts, of which half was shipped from East Africa to India for processing. During 1950s' and 60s there was a major expansion of crop in Mozambique and Tanzania. By 1965 these two countries were producing 75 % of world production and exporting 200,000 MT to India for processing.

In the mid 1970s civil war in Mozambique and internal political problems in Tanzania led to a massive drop in crop collection. A combined crop of 340,000 MT in mid 1970s was reduced to less 100,000 MT by 1980. The resulting world crop shortage led to a price increase of 300 % in processed kernel. The fundamental problems in supply in East Africa and the strong price signals initiated a massive response from other existing and potential new cashew producing countries.

The production changes have been significant in the past 25 years. The world crop prior to the disasters in East Africa in the mid 1970s was about 500,000 MT. This fell to

350,000 MT by 1980, but as a result of the increased plantings since the late 1970s the world crop in normal conditions now approaches 900,000 MT

The current major producers are India, Brazil and Vietnam and very recently Tanzania has regained it's role as a major producer. In normal conditions these four countries would produce 75 % of world production. However in the period 1998/99 past three countries (India, Brazil, Vietnam) have almost simultaneously produced poor harvests due to inclement weather and other reasons.

These were the crops in Brazil (September 1998) India (March 1999) and Vietnam (March/April 1999) This shortage of supply caused a period of significantly increased world prices from April 1999 to about March 2000 when better crops brought prices back to 'normal levels'.

The world crop for 1999/2000 will probably be about 900,000 – 950,000 MT.

Table 1.

	World Production (000 MT Raw Nuts)				
	94/95	95/96	96/97	97/98	98/99
India	310	280	320	280	135
Brazil	190	180	200	175	100
Mozambique	54	40	40	50	50
Tanzania	40	39	47	50	100
Vietnam	40	60	150	120	70
Kenya	18	24	20	20	20
Guinea Bissau	20	25	25	31	30
Nigeria	15	13	15	15	18
Indonesia	30	35	40	50	20
Others	50	55	60	90	90
Total	767	751	917	861	633

Note
1. Others include Sri Lanka, Thailand, Madagascar, Togo, Ivory Coast, Benin, El Salvador, Venezuela, Guatemala, Philippines etc.

2. There is no accurate published data on world production - the above table are estimates based on trade sources. Of the total world crop perhaps only about 65% enters the world trade. Some part is consumed in the villages while another part is processed locally and sold as product in the local retail trade. There is a very large domestic market in India and in some SE Asian countries.

3. India's harvest is March/April, Vietnam April/June and Brazil is September/November

3.3 Cashew Processing and Indian Raw Nut Trade

Up to the 1960's virtually the whole world's crop was processed in India where very cost efficient hand processing methods had been developed. During this time the Indians controlled the international trade in processing and marketing of cashew. Apart from their own crop they imported increasing volumes of crop that was becoming available from Mozambique and Tanzania. By 1960 India processed and marketed 95 % of all traded product.

The dominance of the world trade by India was sustained by the scale of the raw nut import program, especially from Mozambique and Tanzania which peaked at about 200,000 MT in 1972. At this time the total world crop was less than 400,000 MT. During the 1960s and 1970s newly designed mechanical processing factories were installed in East Africa and together with the reduction of crop in those countries encouraged the Indians to expand their local production as well as diversify their sources of raw nut imports. In recent years Vietnam especially, Indonesia and West Africa have become more important sources of raw crop. However this trend is now changing as Vietnam is now encouraging local processing.

Table 2. Indian Raw Nut Imports (000 MT Raw Nuts).

Country of Origin	1994*	1995*	1996*	1997*	1998/9**
Tanzania	55,658	51,346	82,384	42,015	na
Mozambique	7,665	7,665	27,197	14,737	19,124
Vietnam	43,898	14,109	nil	nil	nil
Indonesia	25,821	13,706	16,563	na	14,218
Guinea Bissau	31,410	29,156	9,180	40,498	18,573
Ivory Coast	19,128	23,793	10,814	31,197	21, 237
Others	80,546	53,650	56,208	75,207	107,534
Total	276,369	193,125	202,346	209,598	180,686

* January to December ** April to March

Source The Cashew (India)

Table 3. Raw Nut Import Prices (US$ c & f)

Country of Origin	1993	1994	1995	1996	1997
Guinea Bissau	1,133	1,050	1,192	1,111	925
Indonesia	902	979	1,068	1,097	958
Ivory Coast	944	920	900	876	752
Mozambique	796	700	930	938	903
Nigeria	709	786	789	780	607
Tanzania	777	860	915	1,032	950
Vietnam	832	1,069	900	na	na

The average price for imports from all origins in 1998/99 was US$ 1,009

Source : The Cashew (India), for prices in local currency and converted to US$ by consultant.

The processing industry in India employs about 300,000 people (mainly women) and is estimated to have a capacity to process 500,000 MT raw nuts p.a. As domestic production and imports have not reached this level the industry has previously operated well below capacity. However this spare capacity is being reduced as Indian local production expands.

In Brazil the processing industry has developed to process the whole crop mainly using a mixture of mechanical shelling and semi manual methods and this development has been aided by a total ban on raw nut exports. In Africa (Tanzania/Mozambique) and SE Asia (Vietnam) there is a mixture of local processing and raw nut sales to India. Mechanical shelling especially using Oltremare and centrifugal methods have been extensively used in Africa while in SE Asia semi manual shelling is more popular. While these producing countries would no doubt prefer to process all their crop and sell kernel they face very strong price competition from the Indian raw nut trade who probably have an advantage of about US$ 100 to US$ 150/MT that reflects their cost efficiency in processing. Therefore in most of these countries the development of the local processing industry has been assisted by export taxes (usually 10 % to 20 %) on raw nut exports.

However the prices paid by the Indians for raw nut imports could be reduced in the future if their local production meets their objectives to meet local processing requirements. However opinion is divided if this point can be reached in the foreseeable future.

3.4 Kernel Supply

India was originally the dominant supplier of kernel to the world market but in the past 15 years Brazil has also become a major exporter especially to the US market. Tanzania and Mozambique were previously important suppliers but are now relatively small.

In recent years Vietnam has become a major source of kernel, as the government has assisted the development of the local processing industry by imposition taxes on the export of raw nuts. In 1996 the tax was 4 %. This was raised to 14 % in 1997 and finally there was a total ban on exports imposed 1998.

Table 4. Exports of Kernel (MT)

	1993	1994	1995	1996	1997
India	62,817	78,266	72,436	70,190	74,863
Brazil	29,914	22,709	31,896	36,229	36,297
Vietnam	5,512	9,528	18,162	26,111	32,894
Mozambique	2,654	892	453	**	**
Tanzania	45	nil	113	**	**
Others	2,858	4,996	5,184	11,365	11,343
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Total exports	97,890	106,873	128244	143,895	155,399

Source : Mann Producten Rotterdam

Note - Total kernel exports in others category are probably underestimated by 2,000 to 3,000 mt as some minor exporters may be missed.

In addition information from The Cashew (India) shows kernel exports from India for the period April 1998 to March 1999 to be 75.026 MT.

Trade flows -
The following estimates are made for 1998 for the trade flows between supplying and consuming countries.

Brazil production	- 75 % USA
	- 10 % Canada
	- 10 % Europe
Vietnam	- 25 % USA
	- 20 % Australia
	- 15 % Europe
India	- 45 % USA
	- 30 % Europe

3.5 Kernel Consumption

The total annual world trade in kernels is now above 130,000 MT. The USA is the dominant market and takes about 50% of world trade. The other important markets are UK, Netherlands, Canada, and Japan. China has become a significant market in the past few years.

Table 5. Kernel Imports (MT)

	1993	1994	1995	1996	1997
USA	59,954	61,632	52,677	59,029	65,108
Netherlands	8,593	13,354	8,552	12,409	14,065
Germany	6,892	8,412	9,642	10,821	11,683
Canada	5,537	4,781	4,151	4,537	5,217
UK	6,510	6,019	5,127	6,374	7,032
Japan	5,622	6,193	6,420	6,556	6,578
Australia	3,771	4,488	5,000 *	5,000*	5,000 *
China	4,990	7,509	14,995	17,513	20,417
Others	10,606	12,477	23,753	27,860	21,606
Total	107,485	117,356	125,317	145,099	156,760
re-exports	6,265	10,154	13,000**	16,000**	18,000**
Net imports	101,220	107,202	112,317	129,099	138,760

Source :Mann Producten Rotterdam		
Kernel imports for 1998 as follows	USA	64,405 MT
	Netherlands	16,313
	UK	6,313
	Germany	4,412
	France	4,230

Note : * shows estimates

** re-exports occur mainly from Rotterdam (Netherlands) and also from Hamburg (Germany) and London (UK). These figures are estimates.

In addition to the major traded markets (above) there is also a very large consumption of cashew at the retail level in India supplied from domestic production estimated to be about 25,000 MT. There are also internal markets many S.E Asian countries.

3.6 Kernel Grades and Prices

As the US is the world's largest importer it is the New York market the effectively sets the world prices in US dollars per lb. As India was until relatively recently the world's dominant supplier, it is the Indian system of grading kernel that is most widely used in the trade and is officially recognized by the industry. In the Indian system kernels are characterized by (1) quality and (2) size.

(1) quality

white - white, off white with no blemish

scorched - light brown, faint spots allowed.

dessert - shriveled, scorched, spots allowed.

The quality grades above can be further graded as (3) whole kernel or (4) brokens

(2) Size

wholes, (a) grading of whole white kernel is based on a count per lb, as follows

W450 - 400 to 450 kernels per lb
W320 - 300 to 320 kernels per lb
W240 - 220 to 240 kernels per lb
W210 - 200 to 210 kernels per lb
W180 - 170 to 180 kernels per lb

(b) scorched whole kernel is sometimes graded on a count per lb, but often these grades are mixed.

(c) dessert whole kernel is usually graded as one grade.

broken - graded by size, and can be further classified by (a) white, (b) scorched or (c) dessert.

splits	- lengthwise split in kernel
butts	- crosswise split in kernel
LWP	- large white pieces
SWP	- small white pieces
BB	- baby bits

There are about 30 possible grades of kernel, however the W320 grade (300 to 320 whole white kernel per lb) is used as the benchmark for all price quotes as this is the majority grade by volume (about 40 %) that is supplied to the world market Larger white whole grades are sold at a premium while scorched, dessert, smaller wholes and broken grades are sold at a discount.

The Brazilian cashew trade has it's own system of grading kernel which has similarities to the Indian system. In particular Brazil produces a greater volume of larger kernels and this is reflected in the number of large kernel grades. The table below shows a list of commonly used Indian grades and the Brazilian equivalents

The following table of a recent quote from a major trader demonstrates the relative prices for some of the most frequently traded grades as follows. Of course the relativities shown in this table may change in different market circumstances.

Table 6

Grade	Description	Price (US$/lb)
210	white whole	2.90
240	white whole	2.60
320	white whole	2.35
450	white whole	2.14
SW	scorched whole	2.12
FB	fancy buts	1.80
FS	fancy splits	1.75
LWP	large white pieces	1.60
DW	dessert wholes	1.60
SWP	small white pieces	0.70

The benchmark price usually reflects product from group shippers in India - kernel from other sources may receive premiums or be discounted depending on previous quality and reputation.

For many years almost all crop from other sources was discounted in comparison with Indian prices. However in recent years the Vietnamese processing industry has earned a reputation for good quality - mainly because of the high standards of product grading carried out. As a result and based on market experience in Australia some traders are now willing to pay a premium of perhaps 2 /3 cents /lb from some Vietnamese processors

Prices are set by basic supply and demand factors, however there are a number of micro factors that can lead to short term instability;

- prospects of harvests from different supplying countries as perceived by individual shippers and buyers.
- current stock levels
- transportation problems
- prices of competitive nuts, especially almonds and to lesser degree other nuts.
- political considerations, previously Russian purchases from India could destabilize the market.

In particular it is the incomplete knowledge on future crop expectations frequently due to a lack of accurate data that can cause price fluctuations.

Kernel Prices
In the period 1975 to 1980 kernel prices increase by 250 % reflecting the shortage of crop brought about by the fall in production in Mozambique and Tanzania, However since that time prices have generally remained in the range of US$ 2.35 to US$ 2.70 per lb W320 grade apart from temporary sudden increases due to crop problems in a major producing country.

Table 7.

Kernel Prices (US$ per pound)	**W 320 Grade**
	US$
1985	2.40
1986	3.17
1987	3.18
1988	2.98
1989	2.46
1990	2.39
1991	2.75
1992	2.47
1993	2.38
1994	2.40
1995	2.56
1996	2.68
1997	2.50
1998	2.47
1999	2.95
2000	2.48

Source :1985 to 1997 Mann Producten Rotterdam, 1998 to present from trade sources.

In the period from March 1999 prices rose significantly due to the poor crops in the three major producers India (March 1999), Brazil (Sept 1998), and Vietnam (April 1999). The W 320 price was US$ 2.52/lb in February but had risen 24 % to US$ 3.13/lb by May when the full world crop implications were apparent to the market. Prices have now eased again as the Brazilian crop (September 1999) and Indian and Vietnamese crops (March 2000) appear to be returning to normal volumes.

Table 8

Kernel prices per lb W320 grade (January to September 2000)

	US$
January	2.75
February	2.75
March	2.51
April	2.55
May	2.57
June	2.49
July	2.45
August	2.45
September	2.40
October	
November	
December	

Source : trade sources (Amberwood Trading, Brazil, and CBC Corp India)

3.7 Outlook for World Market

World raw nut production has expanded perhaps 100 % over the past 20 years. The high prices in the period up to the early 1980s encouraged major plantings in both existing and in new producing countries and these trees are now mature.

While in recent years cashew prices have been lower at times on average, however small holders in many countries have continued to plant cashew trees at a more modest rate because they have perceived that it is profitable to do so given the alternative options they may have. In the previous major producers of Mozambique and Tanzania there has also been significant aid from donors to assist these countries to correct their technical problems in the industry and at least regain a better part of their former productive capacity.

Virtually all of the plantings world wide to date have been of seedling trees with their generally poor yields and variable nut quality. There is now a second way of expansion commencing which involves the application of new technology especially in the use of selected grafted cloned trees which will achieve higher yields and improved nut quality. So far this development has only commenced in India to any degree where over 20 years of research is now culminating in the production and distribution of large numbers of grafted trees for planting by small holders. Assuming these trends continue and expand this suggests that the cashew crop will continue to expand at a minimum of 5 % to 10 % per year.

However it also has to be emphasized that cashew is grown as a rain fed crop grown in a wide range of tropical countries, sometimes in countries with unstable economies and government's. The background nature of the growing conditions suggests that the potential always exists for major disruptions to supply if problems occur in a major producer. The example still remains of the 60 % reduction in world supply of cashew by the collapse of the cashew industries in Tanzania and Mozambique in the late 1970s.

On the demand side, consumption has shown the capacity to expand significantly encouraged by the moderate cashew prices in most of the past 15 years. This consumption growth has occurred mainly in the major established markets as follows ;

		MT kernels	
	1989-91 average	1995/97 average	% increase
USA	48,480	58,938	+ 22 %
Australia	2,940	4.800*	+ 70 %
Canada	4,117	4,635	+ 13 %
UK	4,938	6,177	+ 25 %

* 1998/99 consumption in Australia is 5,500 MT, a further 14 % increase from 1995/97 average.

Provided moderate cashew prices prevail the market expects the consumption growth in the major markets to continue - it should be noted that per capita consumption of cashew in Australia already the world's highest was still only 305 grams/person in 1998/99.

The second source of future increased demand for cashew will come from greater consumption in India and South East Asian countries. Trade sources have estimated that the domestic market in India is growing very significantly and currently estimated at about 25,000 to 30,000 MT - the second largest market in the world after the USA.

The conclusion is that apart from temporary high prices (US$2.80/lb W320 and above) due to occasional poor crops from climatic factors, demand and supply factors should remain approximately in the current balance and current prices should be maintained in the US$2.30 to US$2.65/lb W320 for the immediate future.

3.8 Organic Cashew Market

The organic cashew market is a relatively recent phenomenon and there is little firm data on its' parameters. However the following information is available;

- organic market is currently very small, perhaps a total of 500 MT kernels, or 0.05 % of world consumption.

- market currently growing at 10 % to 15 %, with the major demand being Europe (250 MT), North America (200 MT) and elsewhere (50 MT). In North America distribution is mainly through medium/large traders while in Europe it is through smaller natural health food shops. In Europe the importers include Horozon Natuurvoeding (Holland), Rapunzel and Care (Germany) and Bond Commodities (UK). In North America they include Ports West (Canada) and Nutta Once Again Butter (USA).

- the current price premium for organic cashew is about 50 % over normal product, although it can be as low as 20 %. In general organic product is not graded to the standards required by the mainstream market.

- there are a number of organizations that can provide official certification for the production of organic cashew, these include OCIA International in USA and a handful in Europe that are acceptable to European Union (including ECOCER). The product of CORALAMA in El Salvador is certified by OCIA and sold in the Canadian market by Ports West of Victoria BC.

- there is some volume of cashew that is not officially certified as organic being sold as 'organic or naturally grown cashew'. It is unknown what proportion of the organic market is supplied from this source.

3.9 Other Cashew Products

1. Cashewnut Shell Liquid (CNSL)

CNSL is a natural phenol (90 % anacardic acid) contained within the shell and is a by-product associated with the processing of cashew.. The volume of CNSL contained in the shell may vary but in practice some 8 % to 10 % can be recovered depending on raw nut quality and processing method used.

90 % of the CNSL collected is processed into resins for use as fillers in auto brake linings and clutch facings. Other minor uses include marine paints and varnish. There are competitor products to CNSL in the auto industry, some of which - the synthetic phenol's out perform CNSL. However the manufacturers prefer to use CNSL as long as the price is competitive.

The major markets for CNSL are USA, UK, Japan and South Korea. Total world supply of CNSL is estimated at about 45,000 MT with an average price of about US$ 300/mt. Brazil is the major supplier (about 25,000 MT) because the processing system they use (hot oil bath) automatically extracts CNSL. In India and in some other countries only a small fraction of the potential CNSL is collected because of the different systems of processing used. However if the price of CNSL increased significantly these processors could change their processing methods and collect CNSL - this acts as an automatic brake on world prices.

2. Cashew Apple Products

The cashew apple is 5 to 10 times the weight of the raw nut and is very high in both Vitamin C and B12.

	Apple	orange	lime
Vitamin C (mg)	186 – 240	49	45
Vitamin B12	99 – 124	30	trace

Source J.G.Ohler

The cashew apple is a valuable by-product, in many countries especially in Africa it is consumed as fresh fruit. In Brazil there is a major juice industry mainly produced on the larger cashew plantations where the juice processing is undertaken along side the cashew nut processing. In India a number of different products are made including whisky (Feni) in Goa.

The Central Food Technology Research Institute in Mysore, India has listed the potential products that have been made from cashew apples;

1. Juice, sweetened, spiced, carbonated
2. Juice blends
3. Syrup
4. Wine
5. Vinegar
6 Jam
7. Chutney

B ANALYSIS SECTION

4.0 DESCRIPTION OF PROJECT AREA

The project area was selected on the criteria of (1) areas in need of assistance under the AGIL program guidelines and (2) areas that may have potential for cashew production. This selection process has resulted in the project area as being defined as the municipalities of Rabinal, Chisec, San Libertad and Chajul. A description of each municipality is given as follows.

In addition the consultant reviewed the existing cashew growing areas in Guatemala. Currently the main production are from trees planted in municipalities of Esqunitla, Mazatenango and Retalhuleu

4.1 Rabinal Municipality

The municipality is an area of 504 sq km in the department of Baja Verapaz in central Guatemala.The town of Rabinal serves as the principal market town for western half of BajaVerapaz. Climate is hot and dry, the soils vary from fertile to poor, and the topography varies from elevation of 0 to 2,400 meters with hillsides of 50 % slope in many places. The majority of flat land is at about 970 meters elevation.

The population is estimated at about 30,000, 70 % live in rural areas. 83 % of the population are of Maya origin speaking primarily Achi language. 45 % of population are illiterate with less than 10 % of heads of households having exceeded primary grade at school. Rabinal was severely affected by earthquake in 1976 and civil war 1980 – 83 when over 5,000 people were killed in massacres.

Agriculture is the main economic activity with 22 % of population being farmers and 23 % being farm workers. The other main activities are 24 % non agricultural workers and 18 % sales. The principal crops are subsistence corn, beans, tomatoes, coffee, oranges, avocadoes, macadamia nuts and vegetables. There is little livestock production.

The consultant visited the area and had discussions with representatives of Hogar Rural Rabinal, (Carlos Fernandez Donis and Julio Xasquez Solano, Tel 368-0329, 368-1762). It was clear that as the area is extremely variable in elevation and that there is only a very limited area of level land available for cashew. They indicated that there may be about 300 to 400 hectares of available land in the valley of the Matanzas River in the region of Puralha, Tres Cruces. Rivalho, Caliha, Rencimiento. This area was indicated to be at an elevation of 500 metres and have suitable soils and climate for cashew.

4.2 Chisec Municipality

Is located in northern part of Alta Verapaz with an area of 1,488 sq km. Chisec town is 294 km form Guatemala City, it is 230 meters above sea level with the municipality varying in elevation from 146 to 800 meters elevation. The climate varies from hot and humid to semi hot and humid. Rainfall varies from 1,600 to 2,100 mm per year, although it rains through the year, the rainfall is less between March and May. The soils in the municipality are fertile but fragile with erosion a problem once vegetation is cleared.

The population is estimated at 90,000, 89 % of whom live in rural areas. 92 % of the population is of Mayan descent, speaking four native languages. Different surveys have found from 54 % to 74 % of the population illiterate. Chisec was severely effected during the years of civil war.

Surveys found 36 % of inhabitants of Chisec are farmers and another 29 % farm workers, including immigrants to assist coffee and sugarcane harvests. 93 % of Chisec inhabitants reported being directly or indirectly dependent on agriculture or livestock, with the important crops being cardamom, coffee (higher elevations), corn, beans, cocoa and pineapple. Forestry was important but is now declining. Oil is produced in the northern part of the municipality but contributes little to the local economy.

4.3 Municipality of Ixcan

Municipality of 1,582 sq km in northern part of Department of Quiche, on border with Mexico. Climate is very humid, hot subtropical forest, with rainfall varying from 2,000 to 4,000 mm p.a. The town of Ixcan is at 160 meters above sea level. Soils are shallow, fragile with low fertility

Area was initially colonized in 1960, before that there were no permanent inhabitants. The population currently is 62,000, 90 % live in rural areas, and 90 % of population is of indigenous Mayan descent. Different surveys put 38 % to 62 % of people as illiterate. The people of this area were severely affected during the years of conflict in Guatemala, and a number of them fled to Mexico to escape at this time.

50 % of the working population are farmers, 25 % being farm workers. 65 % of the agricultural land is used for grain production, remainder fro coffee and cardamom Surveys indicate that the average family incomes are US$1,486 p.a. for rural areas and US$ 7,052 in urban areas. The high figure for urban areas reflects that a significant part of this working population works for either the central the central government or for international agencies.

4.4 Municipality of La Libertad

An area of 7,047 sq km located in western part of department of Peten.. The area is very humid hot tropical forest, and the capital town is 190 meters elevation. Annual rainfall varies from 1,200 mm to 2,100 mm, and average temperature is 26.3 degrees C.

Population is about 80,000, nearly double what it was six years ago, some of this increase are re-settled refugees. Different surveys put the rural population at 70 % to 90 %, while there are wide variances on the numbers of indigenous (Mayan) inhabitants. Between 30 % to 40 % of the population are considered to be illiterate. La Libertad was severely affected by the civil conflict, particularly during the1980s.

31 % of the working population are farmers, and another 35 % are farm workers. Average family income in rural areas was US$ 1,675 p.a, while it is US$ 5,646 p.a. in urban areas. Only 10 % of the working population had access to credit. Until recently major economic activity was timber cutting, but more recently more diversification has occurred with production of peanuts, sesame, basic grains and some livestock.

The municipality is connected to Flores, the capital of Peten by good roads, and through here to Guatemala City via transatlantic highway. The improvement of roads in La Libertad

In addition the consultant investigated the conditions in the current cashew growing areas in municipalities of **Esquintla, Mazatenango,** and **Retalhuleu**

4.0 EDAPHIC FACTORS

4.1 Soils

The correct soil texture is critical for cashew – **they thrive on deep, well drained sandy loams with a pH of 5.5 to 7.0.** There is little specific information on soils available from official sources in the project areas. Therefore the consultant has relied on local knowledge of growers to firstly

(1) locate areas of potentially suitable soils, and later
(2) soil texture analysis to confirm that the soils are suitable for cashew.

During his visit the consultant was able to identify some potential areas of suitable soils (1), but confirmation of these soils by analysis was still to be carried out (2) at the time of the completion of this report.

1. **La Libertad,**
Two cashew growers in the area of La Cruces, Herildo Esquinal, with 5,000 cashew trees and Aleyandro Reynosa (1,500 trees) appeared to have suitable soils as demonstrated by the growth of their trees. Further investigations show that there may be significant areas of similar soils in the area. A previous study proyecto Desarrollo de la Fturicultura y Agroindustria indicated an area of about 80 km by 30 km of 'suitable soils for cashew from las Cruces to the3 north east. Soil samples were taken from the farm of Aleyandro Reynosa to confirm their suitability.

Unfortunately the other grower at San Francisco, Jorge Fuentes who has 40 hectares of 5/6 year old cashew trees has planted them on clay soils resulting in a poor result.

2. **Rabinal**
The consultant visited the Rabinal area. Hogar Rural Rabinal indicated that most suitable area for cashew would be in the Matanzas river valley, where there were 300 to 400 hectares of sandy soils with pH of 5.5. Arrangements were made to take and analyse soil samples to confirm that these soils are suitable.

3. **Chisec**
The soils of the area were not investigated as the area was discounted for cashew on the basis of an inappropriate rainfall pattern.

4. **Ixcan**
The soils of Ixcan were not investigated as the area was discounted for cashew on the basis of inappropriate rainfall.

5. South Coast.

The consultant visited three areas were cashew is currently gown on the South Coast. Finca La Pangola owned by Francisco Pieters has 6 hectares of 14 old cashew trees. This is located in Suchitpequez, some 15 km north on Nueva Concepcion. There was no information on the soils as no analysis has previously been done, however from the growth of the trees and the crop achieved (best crop 5,600 kg), it can be assumed that the soils are reasonably suitable.

The consultant also visited the area around Willy Woods, where there are a number of growers. The visual inspection of the soil could not reveal more than it was slightly heavy for cashew. A final visit was to the Finca of Jorge Fuentes, located north east of the Retalhuleu – Champerico road. Fuentes grows 75 hectares (90 manzanas) of 20 year old cashew. There was no specific soil information, however a visual inspection of a well showed up to medium levels of clay.

4.2 Rainfall

A general analysis of annual and monthly rainfall (1961-97) for Guatemala in map form is shown in appendix 1. Specific rainfall data for the relevant municipalities are shown below.

The preferred rainfall pattern is a definitive wet and dry seasons, total annual rainfall about 1,000 to 2,000 mm, with minimal rainfall during a minimum four month dry season.

The analysis is as follows.

1. Chisec.

Specific rainfall data comes from San Augustin Chixoy (station no 010501), at 140 metres elevation, some 30 km north east if Chisec town but at a similar altitude. The other information are estimates from the Insuvimen Guatemala rainfall maps.

	San Augustin Chixoy	Insuvimen rainfall map
January	113.3 mm	150 mm
February	69.9 mm	75 mm
March	64.3 mm	60 mm
April	59.7 mm	70 mm
May	155.1 mm	150 mm
June	361.6 mm	350 mm
July	302.5 mm	350 mm
August	291.2 mm	300 mm
September	375.6 mm	350 mm
October	317.9 mm	300 mm
November	202.2 mm	250 mm
December	164.1 mm	175 mm
Total annual	2,477 mm (av 1970 – 80)	2,580 mm (av 1961-97)

The above data suggests that the area has (1) too high annual rainfall, and (2) especially in combination with the excessive rainfall during the ‘dry season’. **Therefore Chisec should be discounted on the basis of inappropriate rainfall.**

2. La Libertad.

The specific data comes from El Provenir station which is about 40 km south west of La Libertad town and the other data from Flores town which is to the extreme east of the municipality.

	El Provenir	Flores
January	70.2 mm	71.5 mm
February	54.5 mm	56.6 mm
March	27.7 mm	37.9 mm
April	39.1 mm	35.2 mm
May	149.8 mm	129.4 mm
June	264.8 mm	209.8 mm
July	224.8 mm	186.0 mm
August	220.6 mm	183.5 mm
September	301.5 mm	227.4 mm
October	235.4 mm	215.6 mm
November	146.3 mm	116.6 mm
December	109.1 mm	83.6 mm
Total	1,843 mm	1,553 mm

Note – (1) average data, 19 years 1970 – 89

The data from El Provenir and Flores shows a satisfactory total annual rainfall (on well drained soil), but a higher than preferred volume of rainfall during a four month dry season. This rainfall pattern may encourage problems with anthracnose, and also may negatively impact on flowering if/when heavy rain coincides with peak flowering. In this event the crop could be reduced for this harvest.

The conclusion is that La Libertad is suitable for cashew, with the reservation about the impact of higher than optimal level of ‘dry season’ rainfall. In years of lower rain the conditions may be very suitable, however at other times of higher rainfall there is the potential of anthracnosis damage and flowering problems.

3. Rabinal

The specific data above comes from Cuculco station, some 15 km east of Rabinal town and also San Jeronimo, 25 km east of Rabinal. Coban is 35 km to the north of Rabinal

	Cubulco	San Jeronimo	Coban
January	3.9 mm	5.3 mm	79.9 mm
February	7.2 mm	6.1 mm	97.0 mm
March	12.9 mm	6.8 mm	70.7 mm
April	30.8 mm	21.1 mm	92.9 mm
May	103.9 mm	71.4 mm	162.3 mm
June	202.4 mm	188.0 mm	286.2 mm
July	141.2 mm	139.3 mm	223.3 mm
August	147.5 mm	147.0 mm	223.7 mm
September	208.2 mm	193.1 mm	282.3 mm
October	18.3 mm	95.7 mm	260.8 mm
November	18.3 mm	26.9 mm	174.9 mm
December	8.7 mm	7.9 mm	120.9 mm
total	903.3 mm	1,250 mm	2,074 mm

NOTE average data 1970 – 89

It is clear that the area around Rabinal has a very variable rainfall, the rainfall maps suggest that annual rainfall may vary from about 600 mm in Sierra de Chuacus mountains about 10 km south of Rabinal to about 4,000 mm in the area 75 km north east of Rabinal. The various mountain ranges and steep valleys obviously influence this great variation in rainfall.

Rabinal (Cubulco) has a just acceptable total annual rainfall. However this average of 903 mm total would include variations in individual years, for example data from Cubulco for 1999 indicates a total rainfall of 1,463 mm with a total of 118 mm over a six month dry season – overall a highly suitable rainfall pattern. There would also be years when total annual rainfall drops below preferred minimum levels – about 800 mm. In these years and depending on soils conditions the crop could be effected by moisture stress.

Hogar Rural Rabinal had indicated that the area around the Matanzas river (35 km north east of Rabinal) was a suitable area for cashew. It is apparent that 300 to 400 hectares of land available for cashew growing in this area. While no official data was available this area has a very defined dry season, with a total annual rainfall of 2,000 mm. In addition the area is at about 300 to 500 meters elevation with sandy soils. This is an acceptable level of total rainfall and a highly satisfactory dry season and could be considered potentially suitable.

4. St Juan Cotzal

The information come from (1) Sacapulas, 18 km south of St Juan Cotzal, (2) Chixoy, 40 km to the east, and (3) Nebaj, 15 km to south west.

	Sacapulas	Chixoy	Nebaj
January	2.3 mm	20.9 mm	33.6 mm
February	3.8 mm	24.0 mm	30.8 mm
March	10.8 mm	24.1 mm	30.5 mm
April	18.5 mm	53.3 mm	48.5 mm
May	78.6 mm	110.6 mm	120.9 mm
June	158.6 mm	207 9 mm	317.9 mm
July	117.1 mm	153.1 mm	306.4 mm
August	133.1 mm	176.3 mm	352.6 mm
September	198.4 mm	222.3 mm	332.7 mm
October	92.8 mm	144.0 mm	232.8 mm
November	16.7 mm	68.2 mm	69.2 mm
December	3.4 mm	33.4 mm	49.7 mm
Total	834 mm	1,238 mm	1,925 mm

Data from Insuvimen (Datos Meteorologicos de Las Cabeceras Departamentales

4. Ixcan

There is no specific rainfall data for Ixcan municipality. The nearest specific data come from San Pedro Soloma, some 40 km south west of Ixcan and at an elevation of 2,260 metres and is therefore not representative of Ixcan which is at 300 to 600 metres elevation

dry season	December	200 mm
	January	250 mm
	February	200 mm
	March	150 mm
	April	100 mm
wet season	May – Nov	3,100 mm
total annual		4,000 mm.

On the above basis the Ixcan area has no defined wet season and therefore it must be considered unsuitable for cashew production, because the 'dry season' is far too wet which would have a very significant negative impact on flowering, while the total annual rainfall is also well above what is regarded as optimal.

5. South Coast (Esquintla, Mantenango, Retalhuleu

There is no metrological station on the coastal plains which would be the prime location for cashew production. The existing stations are on then higher ground well back from the coast. The rainfall map indicates the a well defined rainfall wet and dry pattern along the south coast with total annual rainfall ranging from about 1,000 mm to over 2,000 mm, the the volumes increasing the greater the distance from the coast. The only specific data available is from the Finca La Pangola which is nearly 40 km from the coast.

January	11 mm
February	10 mm
March	28 mm
April	112 mm
May	269 mm
June	391 mm
July	322 mm
August	360 mm
September	471 mm
October	346 mm
November	91 mm
December	1 mm

Total	2,412 mm average for 26 years

The rainfall from La Pangola shows a very suitable four month dry season, however the total annual rainfall is slightly higher than preferred. While the rainfall rainfall regime can be considered suitable at La Pangola, it would be better if the plantings were located nearer the coast where the wet / dry seasons are clear but the total annul rainfall was less.

4.3 Temperature

Available data from Insivumen for period 1970 to 1989 for different municipalities show the following,

1. Average Maximum/Mimimum

	Rabinal (944 meters)		Libertad (125 meters)		Chisec (140 meters)		Cotzal (680 meters)	
	max	min	max	min	max	min	max	min
Jan	27.1	10.6	28.0	17.0	28.4	17.6	28.6	14.8
Feb	27.9	11.5	29.1	17.3	29.7	18.1	30.0	15.1
Mar	30.3	12.6	32.2	18.2	30.7	18.9	33.1	16.3
Apr	32.2	14.4	33.6	19.7	33.7	20.3	33.8	17.6
May	32.2	16.2	34.8	21.2	35.0	21.7	34.3	19.1
June	30.0	16.9	32.9	21.5	33.0	21.7	31.8	19.5
July	28.8	16.3	32.0	20.9	32.1	21.1	30.8	19.0
Aug	29.1	16.2	32.3	21.1	32.5	21.4	31.0	19.2
Sept	28.7	17.0	32.0	21.5	32.5	21.5	31.2	19.3
Oct	27.7	13.9	30.9	20.8	31.0	21.0	29.9	18.6
Nov	27.7	13.9	29.6	19.3	30.2	19.2	29.3	17.1
Dec	26.8	11.8	28.2	17.9	28.5	18.3	28.7	15.7

2. Absolute maximum/minimum

Jan	32.0	5.3	34.5	7.8	32.7	13.8	36.5	5.4
Feb	33.0	6.8	37.2	9.0	34.5	14.2	39.4	5.6
Mar	35.2	8.5	41.0	10.2	37.7	14.6	43.6	8.6
Apr	36.1	10.6	41.9	10.5	38.3	16.3	42.6	10.1
May	35.4	12.2	40.2	15.3	38.3	18.8	43.4	12.6
June	33.1	14.4	38.2	18.0	36.8	19.4	40.2	13.0
July	30.9	14.1	35.8	18.0	34.6	19.5	37.4	13.4
Aug	31.1	13.7	38.0	18.0	35.2	19.7	36.7	15.0
Sept	30.8	13.9	35.8	18.5	34.7	19.6	36.8	13.8
Oct	30.9	10.0	36.6	15.0	34.3	18.6	35.2	12.4
Nov	30.9	10.0	36.6	13.5	33.4	16.3	35.3	11.0
Dec	30.8	7.0	39.5	8.0	32.5	14.1	35.6	5.5

Cashews thrive at higher temperatures ranging from 15 degrees C to 38 degrees C. An ideal overall average may be 27 degrees C. Mature trees can tolerate low temperatures, but growth can be restricted if low temperatures (9 to 20 degrees C) are experienced over an extended period. Young trees can be killed by frost.

Chisec appears to have the best temperature regime, but is already discounted because of an unfavourable rainfall pattern. **La Libertad** can also be considered very suitable, given that the data source of El Povenir station is in the extreme inland (and coldest) part of the municipality.

The information for **Cotzal** comes from Chixoy station at 680 meters elevation. This shows a slightly lower but still acceptable temperature regime. However it is apparent that the Chixoy station is not typical of the climate of Cotzal district, the majority of the land is at higher altitudes and therefore Cotzal municipality should be discounted from a temperature criteria.

The information for **Rabinal** comes from Cubulco station (944 meters). This shows a lower than optimal temperature regime, however the restriction should not be significant and the area can be considered as having potential for cashew, especially if the land identified for cashew is at lower altitudes than Cubulco station. The Matanzas river area indicated as suitable for cashew by Hogar Rural Rabinal is at 300 to 500 metres elevation and could be considered to have a very suitable temperature regime.

Data on the **South Coast** on temperature is available from Retalhuleu, 205 elevation and some 35 km from the coast.

	av maximum	av minimum
January	34.5	19.5
February	36.0	18.4
March	37.2	19.0
April	35.4	22.2
May	34.0	22.0
June	32.4	21.4

July	32.8	21.5
August	33.3	21.6
September	30.8	21.5
October	31.5	21.1
November	32.5	21.4
December	33.5	15.8

The above temperature can be considered highly suitable for cashew.

4.4 Humidity

There is no good information about humidity and cashew growth, and cashew can grow well in quite differing conditions. For example in Brazil in the arid interior with a average humidity of 50 % tom the humid coast where it is 80 %. In regions where humidity is high however can encourage the incidence of disease, especially *anthracnosis.*

There

	La Libertad	Chisec	Rabinal	South Coast	no information For Ixcan
	La Provenir	S Augustin	Cubulco	Retalhuleu*	
January	89 %	87 %	77 %	63 %	
February	86 %	85 %	76 %	61 %	
March	82 %	78 %	77 %	59 %	
April	78 %	75 %	74 %	64 %	
May	74 %	77 %	77 %	73 %	
June	84 %	83 %	82 %	77 %	
July	88 %	85 %	81 %	77 %	
August	86 %	85 %	83 %	82 %	
September	88 %	86 %	84 %	79 %	
October	89 %	87 %	80 %	72 %	
November	90 %	88 %	80 %	71 %	
December	90 %	89 %	80 %	71 %	
Average	85 %	84 %	79 %	71 %	

Retalhuleu is probably is reasonably representative of the south coast being only 205 meters high. Despite a high rainfall of 2,890 mm , it has the best humidity levels for cashew as the lower levels would help minimise the prospects of fungus diseases like *antracnsosis* in cashew.

La Libertad has shown a potential to grow cashew, however the higher humidity levels will mean that attention will have to be given to the control of *anthracnosis.*

6.0 TECHNICAL DETAILS - NURSERY

6.1 Nursery Infrastructure

The nursery should be located on level ground, and in sheltered position (away from strong wind). It must be located close to a source of water. There should also be a sufficient sheltered area adjacent to the nursery to allow the young trees to be held for two weeks in full sunlight prior to planting in the field.

It is important to have sufficient area in the nursery for both (1) holding trees and (2) for working space. With two litre planting bags of 10 cm diameter there are 100 bags /sq meter. Allowing for 60 % working space, this requires a nursery area of 250 sq meters or 16 by 16 meters to propagate 10,000 seed.

The following items are required for the nursery operation

- shade cloth (50 % sun penetration) for roof, need to avoid direct contact of sun on seedlings, so may also need walls of shade cloth, say 1 meter of shade hanging from roof.
- water supply, either overhead sprinkler system, or hose that allows application of water by hand.
- planting bags of poly material, size 2 litre, of dimensions 10 cm and height 25 cm.
- growing medium, a suitable mixture is 50 % coarse sand and 50 % sandy loam soil.
- slow release fertilizer (NPK) in granule form
- foliar fertilizer (NPK + micro- nutrients)
- elements for possible nutrient disorders, (Iron chelate and Zinc heptahydrate)
- insecticide, dimethoate (40 % active), together with backpack spray and protective clothing.

6.2 Preparation

(a) The planting bags must be filled with the growing medium, and a small amount of slow release fertilizer is added. The planting bags can be placed in groups of 100 in the nursery.

(b) The cashew seed is sown in the planting bag, 1 cm to 2 cm below the surface of the soil. The seed should be positioned with the curve of the seed facing upwards.

(Note, when using seed of unknown quality, it is recommended to undertake a float test on the seed prior to planting. The float test involves putting the seed in a shallow tank of water to determine whether the seed contains developed kernel or not. Those seed that float should be discarded, while those that sink can be used for planting).

(c) The seed will usually take about 15 to 20 days to geminate

6.3 Nursery Operation

(a) The planted seed should be monitored **on a daily basis** for any signs of abnormalities (insect attack, nutritional deficiency etc).

(b) **Water** should be applied on regular basis, twice a day may be appropriate in hot humid conditions.

(c) An application of **NPK foliar nutrition containing micro-nutrients** should be commenced once the young seedlings are about 10 cm in height, this application to be repeated every two weeks while seedlings are in the nursery. The foliar application should be used with a wetting agent to improve the uptake of the nutrients by the seedling.

(d) Any **weeds** found growing in the pots should be removed by hand.

The objective is to grow the seedlings to a sufficient level of maturity inside the nursery to allow them to be moved outside into full sun for a '**hardening off'** or acclimatization process. The seedlings are ready to move from 'under shade' into full sun, in a position just outside the shaded area when the following situation applies,

- the seedlings appear healthy
- they have grown to a height of minimum 25 cm, and up to acceptable 30 cm
- the plant has sufficient foliage so that it shades the soil in the bag (it is important that the soil in the bag does not become too hot).

The time taken for the seedlings to grow to 30 cm will depend on the conditions, however in normal circumstances this could be from 8 to 10 weeks.

The move into 'full sun' is to allow them to grow further while fully acclimatizing to the weather conditions in the field prior to planting. The time spent in the 'hardening off' phase will depend on what conditions are likely to be experienced in the field, For example,

1.**If conditions in the plantation are expected to be good**, ie favourable weather conditions, well prepared planting holes, no weed competition, good management in the field, then the trees could be trans-planted when the have attained a height of about 35 – 40 cm, after about 2 to 4 weeks in the 'hardening off ' phase.

2. **If conditions in the plantation are expected to be poor,** ie less favourable weather conditions, weeds, less well prepared planting holes, possible less attentive management, then the trees should be grown to a larger size, ie at least 45 cm before transplanting. In this situation the trees may be held in the 'hardening off' phase for 4 to 6 weeks.

It is necessary to guard against holding the trees in the nursery (and remaining in the bags) for too long a period, or **the root system will become 'pot bound'**. This is a condition where then root system has out grown the area available in the bag, and probably be reached if the trees are still contained in the bag at 6 months of age.

There are two likely problem areas with the seedlings in the nursery (see below), and these are described in the following paragraphs

- nutritional deficiencies
- insect pest damage

6.4 Nutritional Deficiencies in the Nursery

The best defence against nutritional deficiencies is to apply a foliar spray containing micro – nutrients as indicated in 1.3 (c) above. However if deficiencies are to occur the most likely are of (1) iron, and (2) zinc

Iron Chlorosis

Deficiency of iron can cause high mortality in young seedlings. In the early stages of the deficiency the seedlings growth will be affected, later visible symptoms perhaps after 4 weeks will appear, where the whole leaf except the leaf midrib turns yellow. In addition after 8 – 10 weeks black spots will be seen on the leaves, these spots may give the appearance of a fungal attack.

The recommendation is to take a proactive approach and not wait for any symptoms to appear, because by the time symptoms are evident much damage has been caused. At 6 weeks of age apply a mixture of one tea spoon of **Iron Chelate** to 10 litres of water. This mixture is probably best made up in watering cans and applied as a drench on the seedlings. One application of iron chelate will very likely be sufficient to eliminate any chance of a problem.

Zinc chlorois

The symptoms show the development of reduced leaf size and subsequent poor growth of the seedling. If symptoms appear it is necessary to apply an aqueous 0.1 % solution of **zinc heptahydrate** (or other) to the seedlings. One application is usually sufficient to cure the deficiency and normal leaf size and growth is restored.

3.5 Pest Damage in the Nursery

There is very limited information on pests of cashew in Central America. *Leptoglossus zonatus* (chinche), and other species are known to be a major pest of cashew in El Salvador, and chinche is known to breed and feed on a range of other crops such as curcubits, maize, sorghum etc. However chinche is usually associated with attack on developing crop in cashew and so is likely to be an issue with small seedlings in a nursery.

It is estimated that the following insects may be the prime cause of damage in the nursery,

- thrips, especially *Selenotrips rubrocinctus*
- aphids, possibly *Aphis gossipi*
- mites
- caterpillars

Thrips – a more detailed description of thrips is given in the plantation section, however in general thrips are very small sap sucking insects that concentrate their activities on the underside of the leaf . Their main impact is to remove fluids from the seeling and hence they reduce the health of the plant, and in severe cases this could cause death in young plants.

Aphids and mites are also small insects that feed by sucking sap and having a debilitating affect on the seedling. Mites will be found on the underside of the leaf. Caterpillars are leaf feeders and from second instar to adult status can destroy significant quantities of leaf tissue.

The recommended solution is for a **careful daily monitoring of the seedlings** in the nursery to be undertaken by a person with to evaluate the insect status of the trees. If this level of monitoring is possible then the timing of remedies can be left to when a pest threshold has been reached. However if expert monitoring is not possible then it is recommended to undertake a regular program of prophylactic sprays to maintain control.

The recommended approach is

- remove all caterpillars found on the leaves by hand. Their numbers and presence are likely to be low.

- spray with dimethoate (40 % active) at ratio of 1 : 1,500 every 3 weeks. (this chemical requires operator to use protective clothing. Note, alternative chemical can be used depending on local availability.